Quakesim Computational Environment

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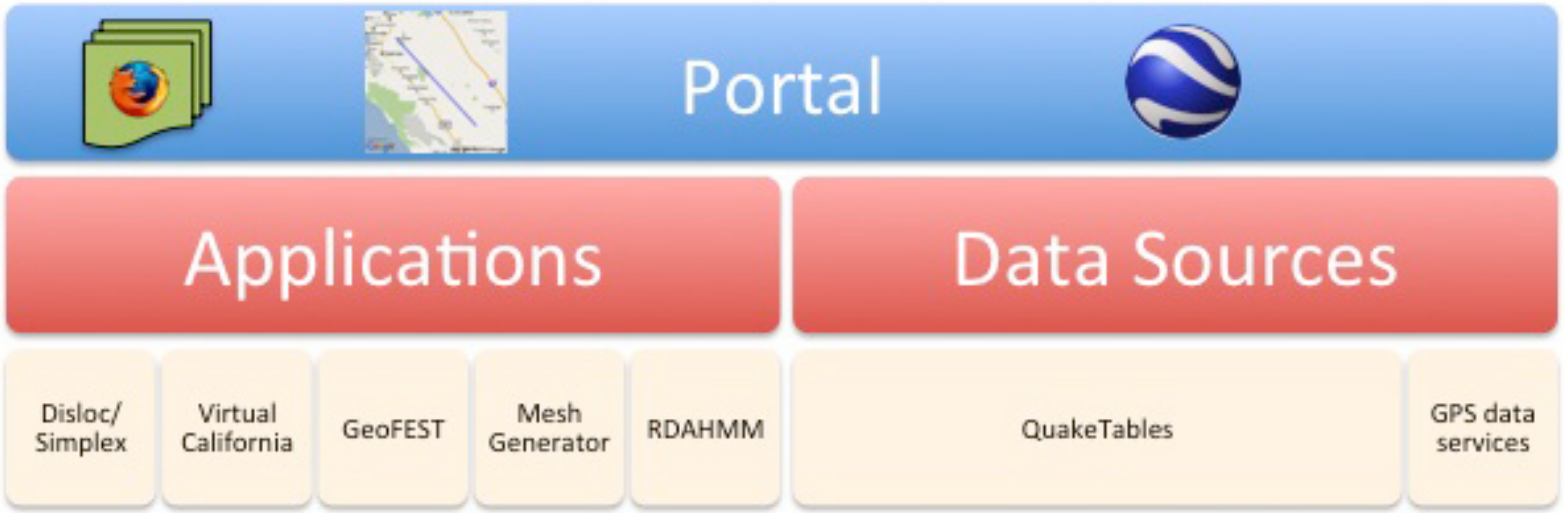
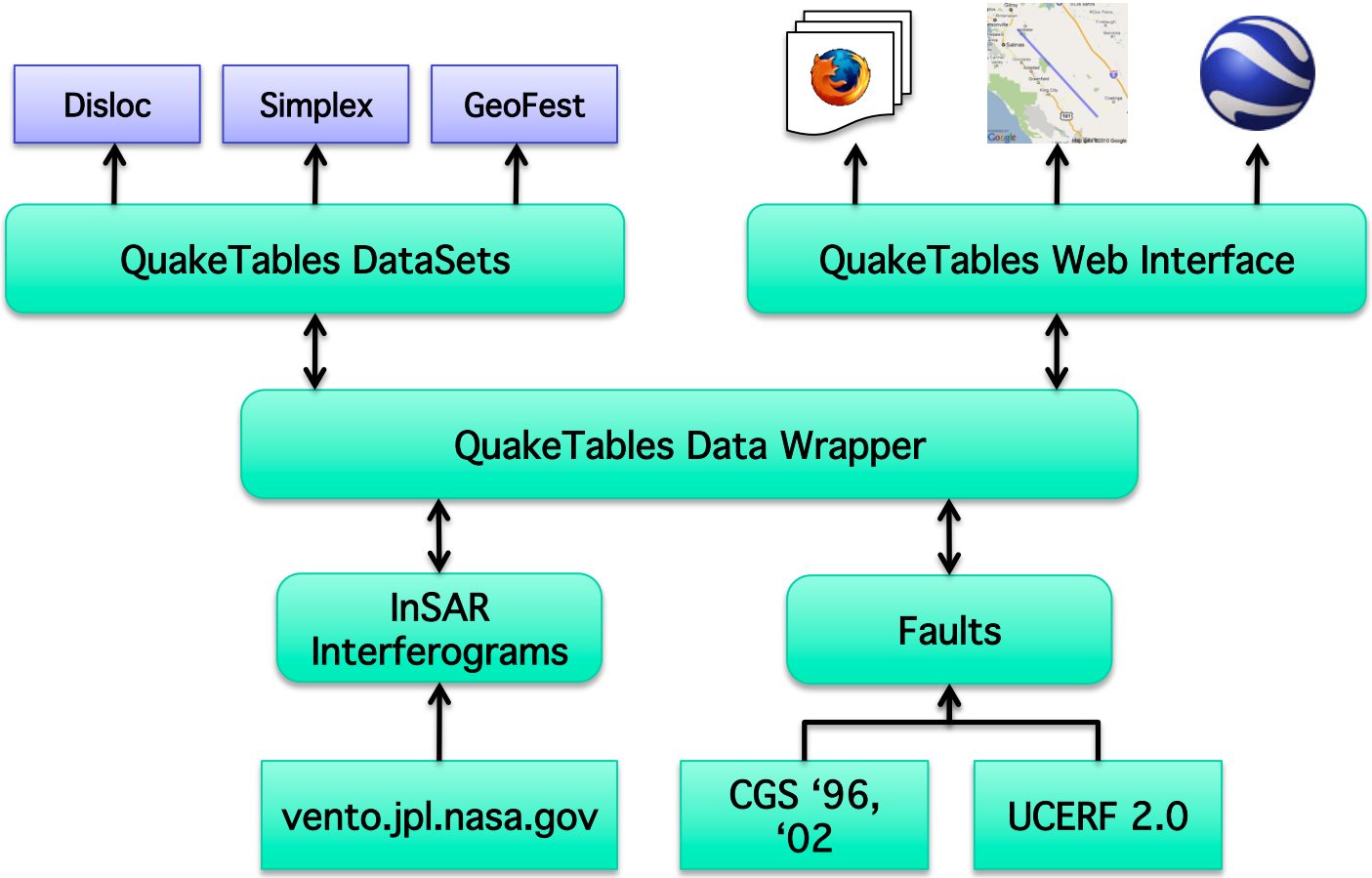
QuakeSim Computational Environment



- Integrates
  - Multiple heterogeneous data sets
  - Crustal deformation modeling tools
  - Pattern recognition techniques for studying earthquake processes and forecasting their behavior
- Recent developments largely use case driven
  - Improved mapping and visualization tools for exploring and selecting data
  - Enhancement to model applications
  - Addition of UAVSAR data to the QuakeTables database
  - Improved pattern analysis methods

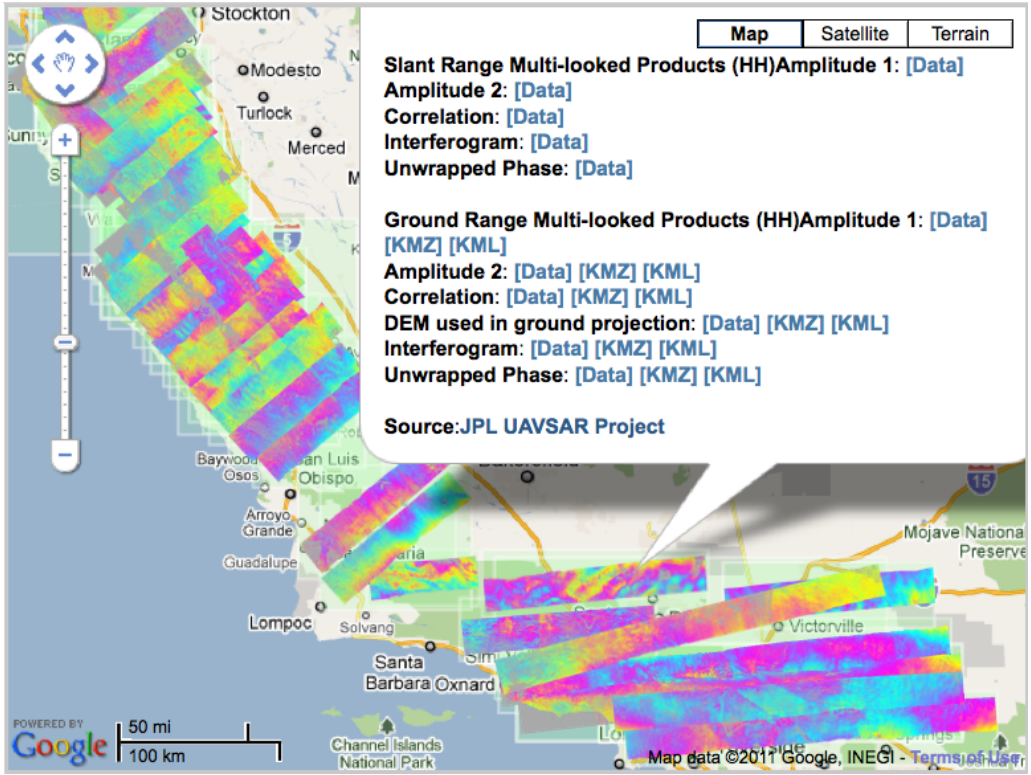
QuakeTables

- Present the data in a form useful to modelers
- Focus on map browse products



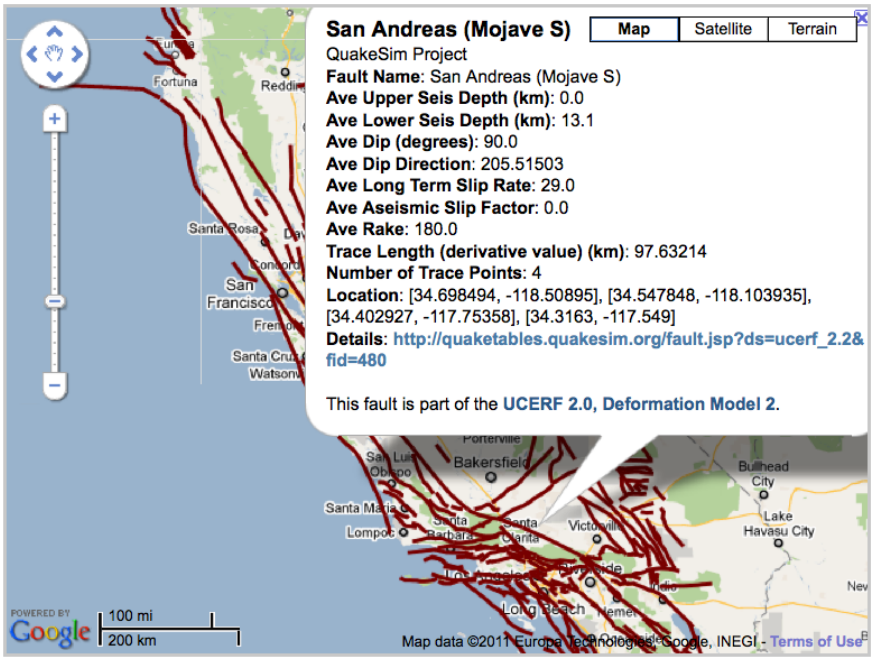
QuakeTables - InSAR

- InSAR data
  - UAVSAR
    - Map browse interface
    - All products are available for download
    - Time stamped KML files
      - Viewable in Google Earth in timeframes for which the data were collected
  - Spaceborne missions
    - Processed California data



QuakeTables – Fault Database

- Uses a reference fault specification
  - "QuakeSim Format"
- Data incorporation
  - Conversion scheme from and to QuakeTables is set as part of the metadata for this new dataset
- Need to ensure that different fault interpretations interface with modeling tools
- Map tools
  - Browse the database and select faults to model
  - Draw faults directly on a map for modeling
    - Earthquakes and deformation often occurs on unmapped faults or fault segments



Forecast
Based on Pattern Analysis of Seismicity

QuakeSim.Org

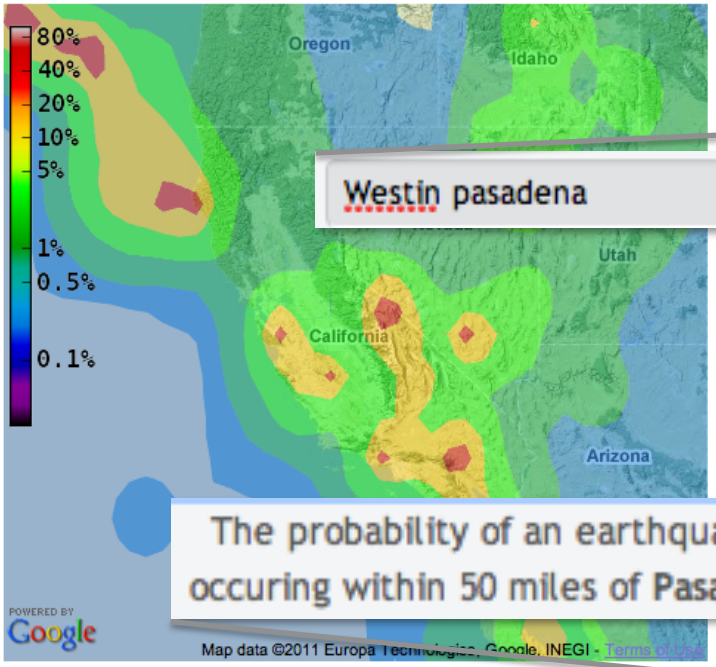
Spin off

OpenHazards.com
Earthquake Forecasting and Hazard Analysis

Main Store Blogs Forums Information Tools Da

Latest Analysis

Forecast | Station Monitor | Scorecard



Westin pasadena

Search

!

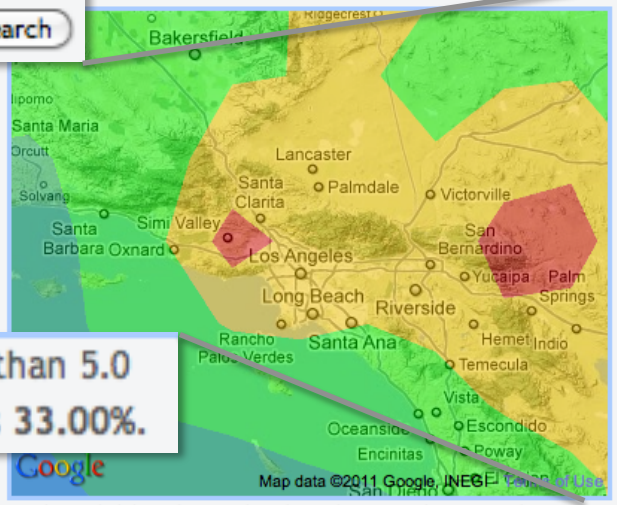
Personal Earthquake Forecast

Home

Create a personalized forecast for M>5 earthquakes near your current location.

westin pasadena

Search



The probability of an earthquake with magnitude greater than 5.0 occuring within 50 miles of **Pasadena, CA** in the next year is **33.00%**.

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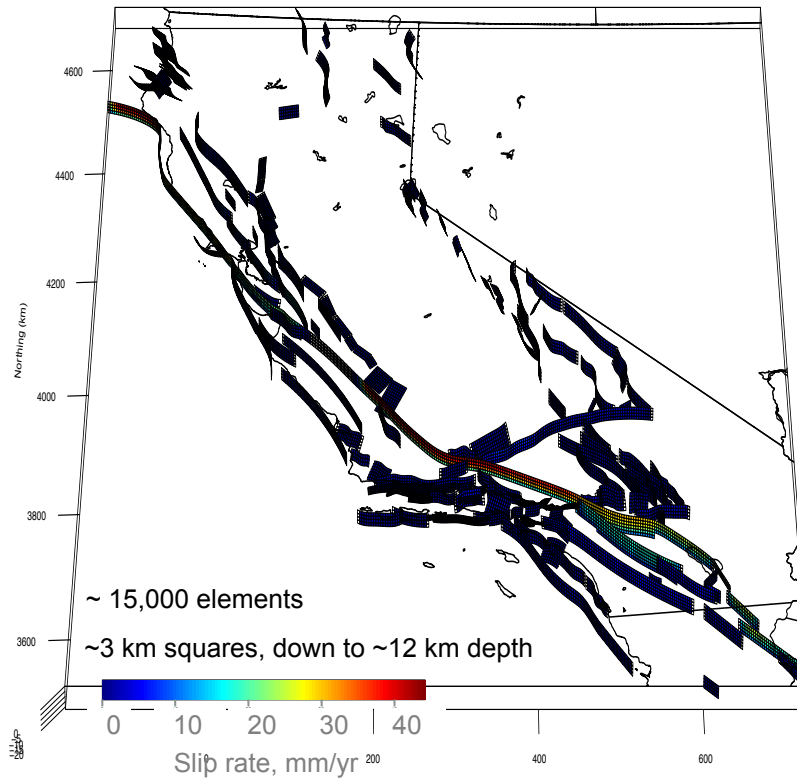
Southern California Earthquake Center
Earthquake Simulators Comparison Project

Allcal2 Model

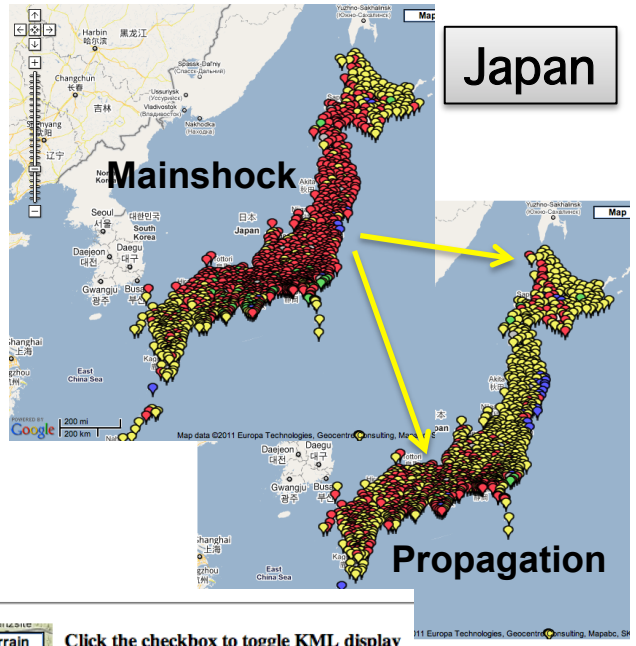
Essentially the UCERF2 Fault and Deformation Model

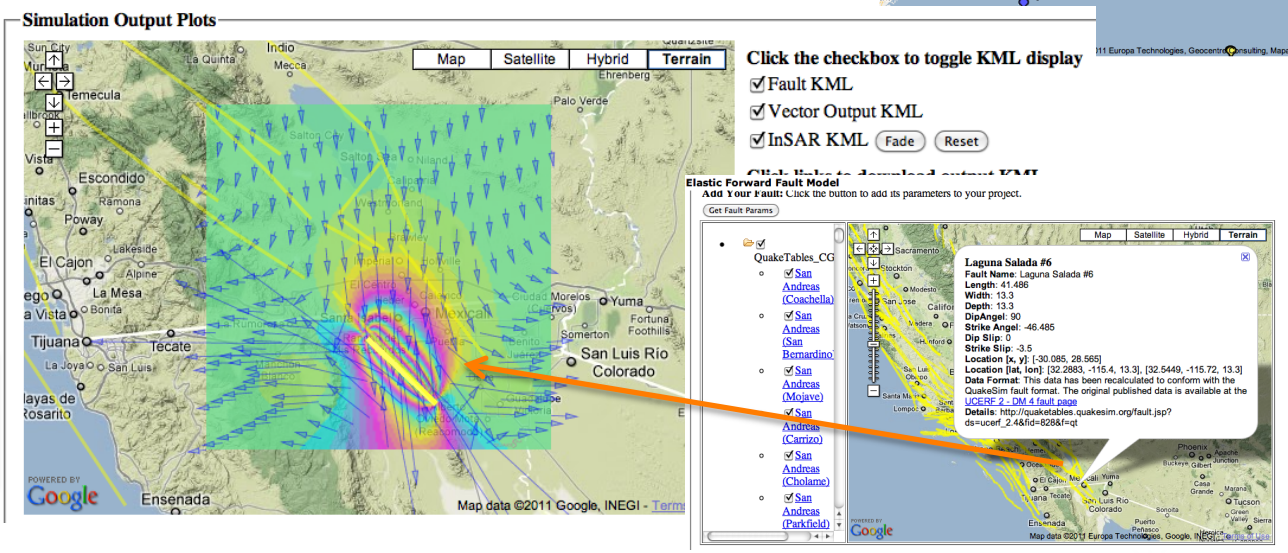


- Simulate interacting faults
  - Simulators provide long time histories for statistical evaluation
- Simulators may play a more central role in future fault hazard models
  - Previous versions rely on "voting" to establish hazard
- Establish tools and formats
  - Sharing model input/output
  - Enables comparison of methodologies

Portal

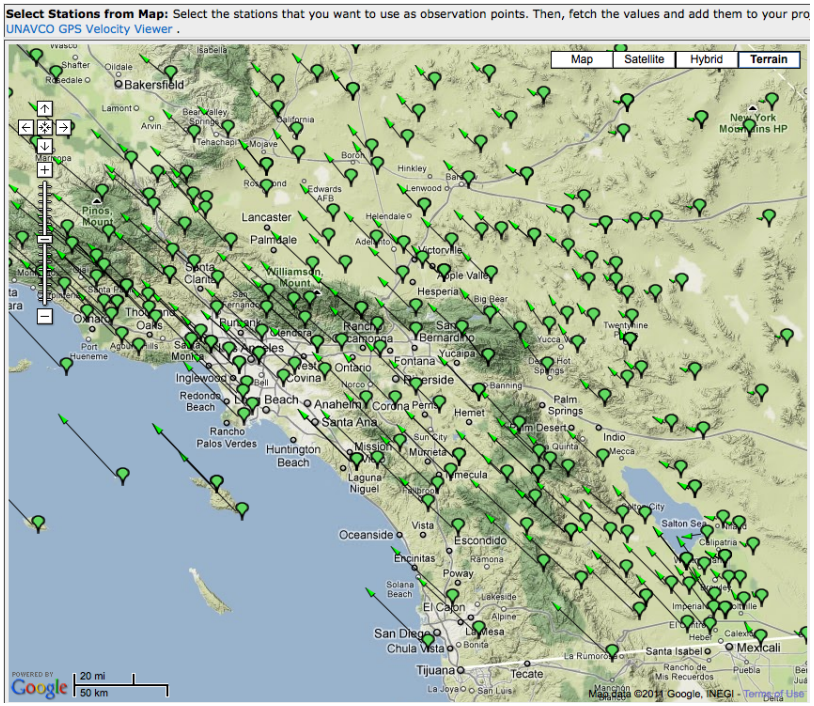
- Recent enhancements based on
  - Lessons learned from science analysis
  - Assessment of user access
  - Response to recent earthquakes
- Do not require users to create accounts
  - For various reasons users don't want to create accounts
  - Move applications outside of a login to the portal
  - Improve ease of access
  - Encourage use of QuakeSim tools
- Time series analyses interface and forecast
  - Public
  - Regularly updated
- Public version of fault deformation model tool





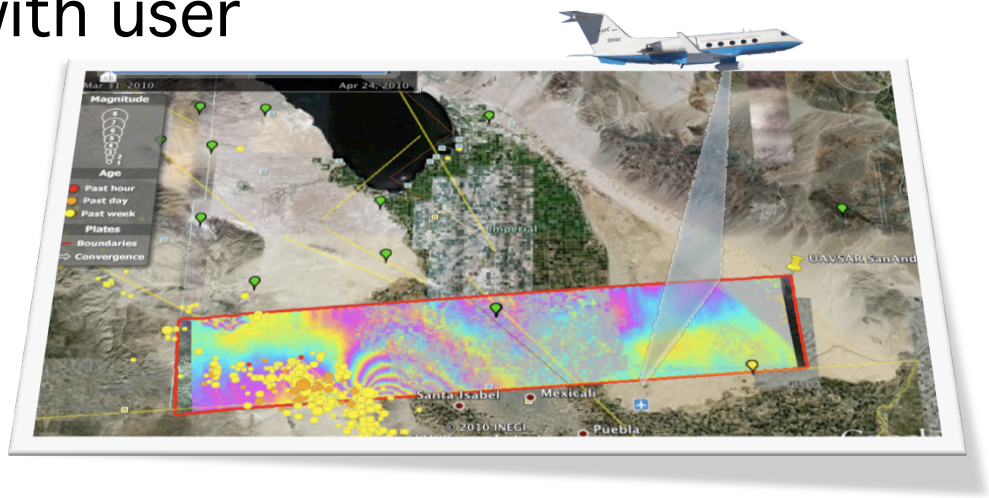
Accessing Data Services
Lesson Learned

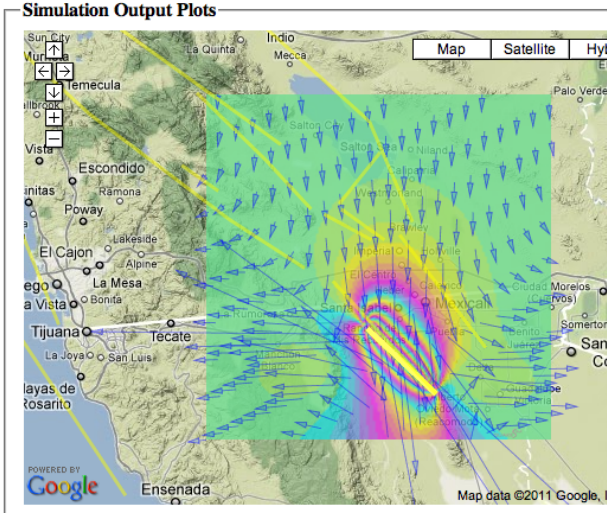
- GPS velocity solutions
  - Various time frames
  - Various reference frames
- QuakeSim applications need to access as many of these solutions as possible
  - Different solutions are impacted by
    - Earthquakes
    - Processing methodology
    - Post-seismic motions
    - Easier to interpret in one reference frame versus another



Mapping and Visualization Tools

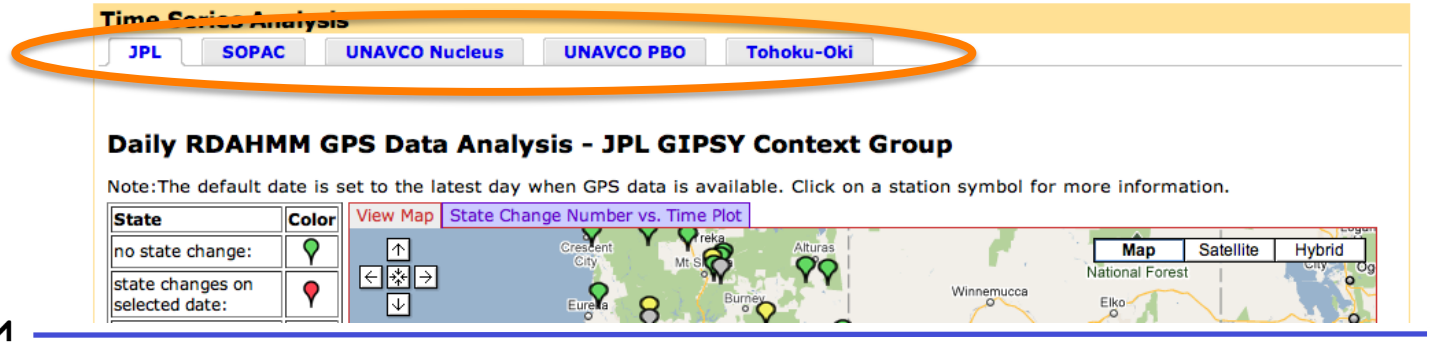
- Plotting tools associated with user interfaces improves usability
- Crustal deformation model produces interferogram for comparison with real data
  - Airplane heading and altitude
  - Ability to compare models with UAVSAR fringe interferograms
- Automatically show the appropriate number of GPS velocity vectors on the map





Lower Latency Data/Product Access

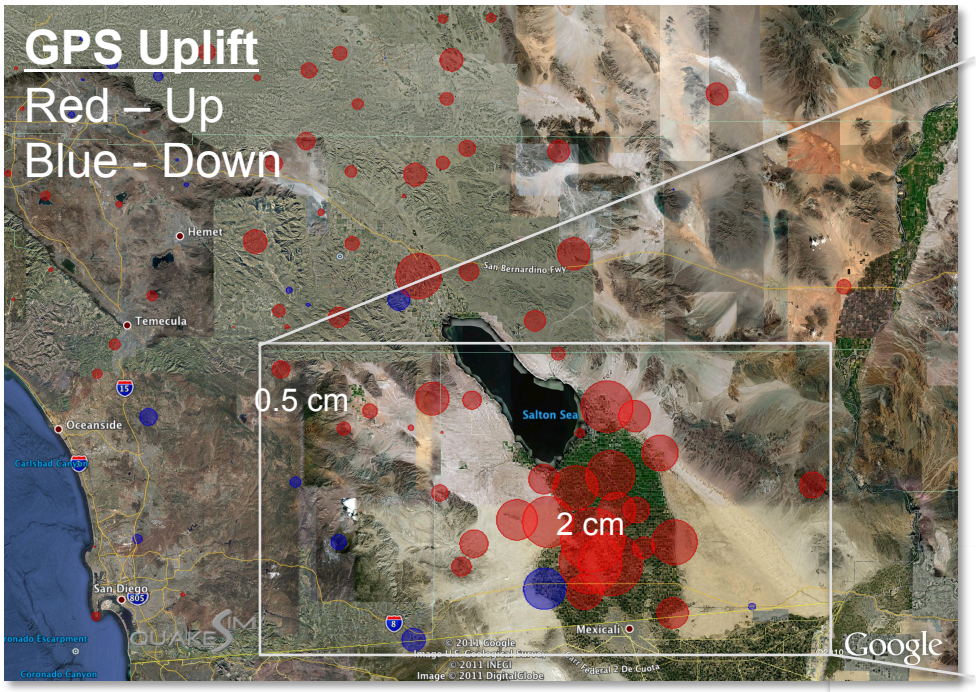
- Recent M 9.0 Tohoku-Oki earthquake highlighted the need for low-latency GPS position time series
  - RDAHMM time series analysis
  - Lower latency in US necessary
- User interfaces displays multiple analyses
  - In discussion with other GPS analysis centers about obtaining more rapid solutions
- Processing centers are recognizing the value of automated pattern recognition
  - RDAHMM highlights state changes in GPS stations
  - Volume of data and solutions makes it too difficult to analyze the data manually
  - RDAHMM provides an automated approach for doing this

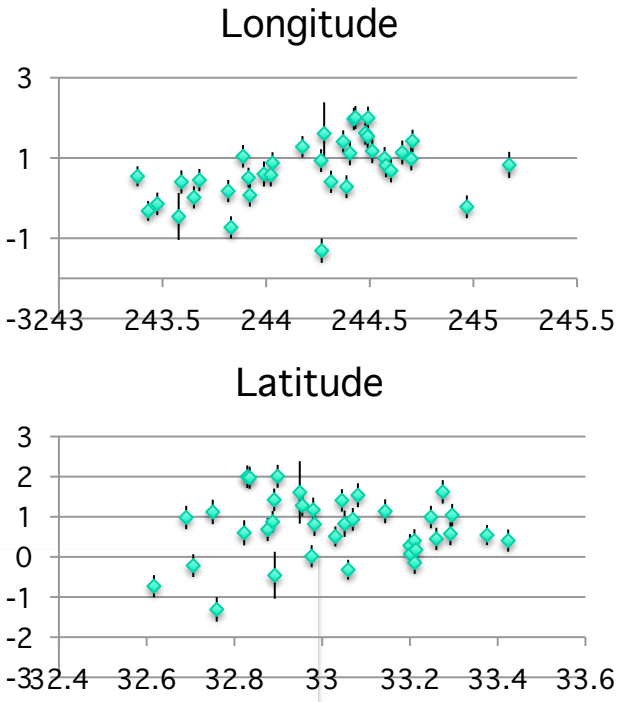


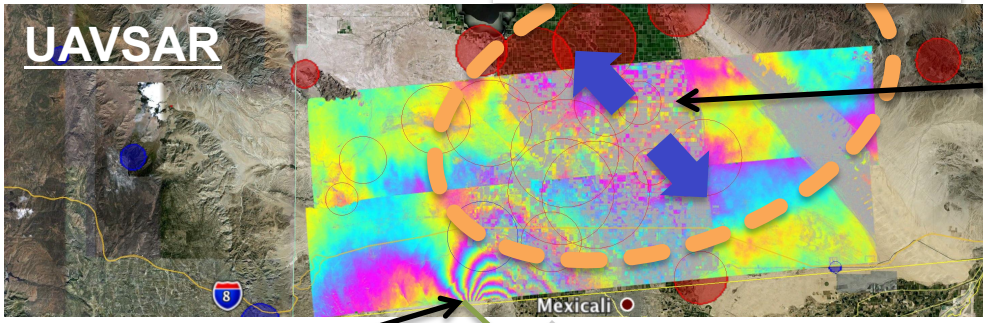
Recent Earthquakes

- Provide diverse and rich model environment
  - Position time series at each station
  - Station velocities
  - Station offsets
  - UAVSAR data
- Events
  - M 7.2 El-Mayor/Cucapah earthquake that occurred in Mexico on April 4, 2010
    - Well instrumented with continuous GPS stations in California
    - Large offsets and uplift were observed at the GPS stations
      - Co-seismic fault slip
      - Fault slip from large aftershocks
  - April 11, 2011 M 9.0 Tohoku-Oki earthquake in Japan
    - Well instrumented
    - Large enough that 30 minute GPS position time series could be analyzed for information

M 7.2 El Mayor-Cucapah Earthquake
Leaky Transform Magma Intrusion?





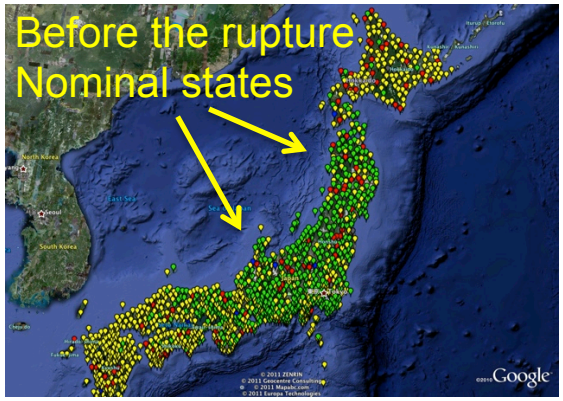


Dome of uplift

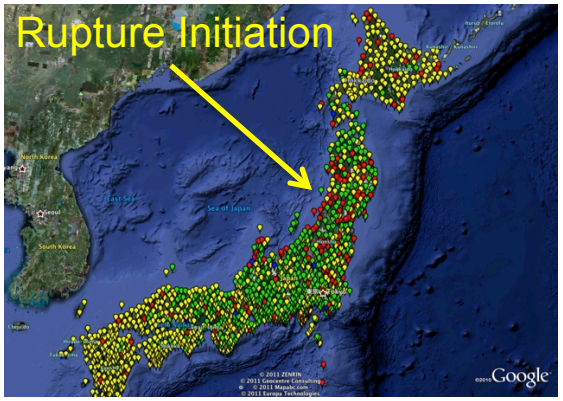
Mainshock
Right-lateral/Normal faulting

M 9.0 Tohoku-Oki Earthquake

March 11, 2011 0500 UTC



March 11, 2011 0530 UTC



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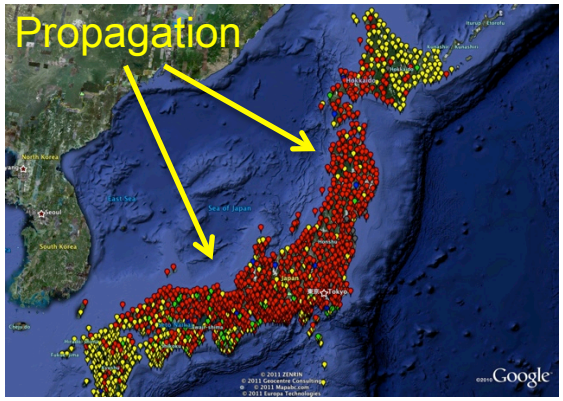

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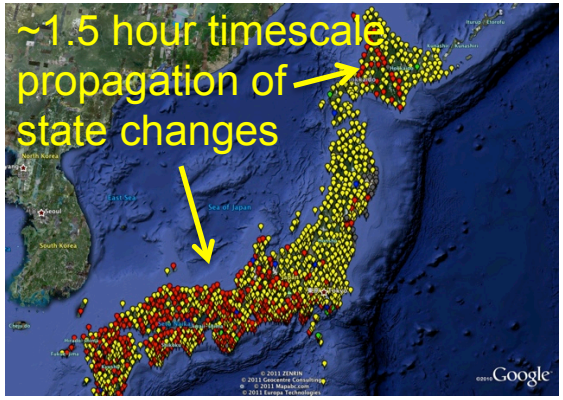
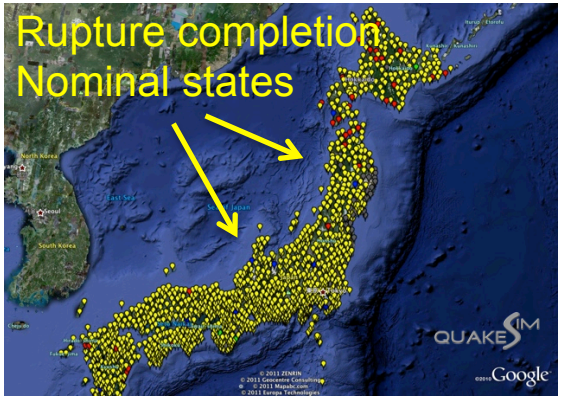
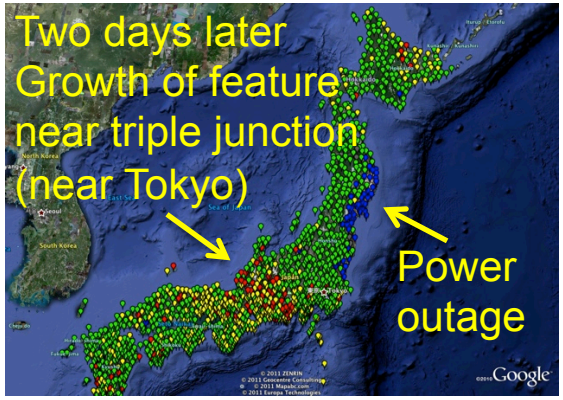


March 11, 2011 0700 UTC



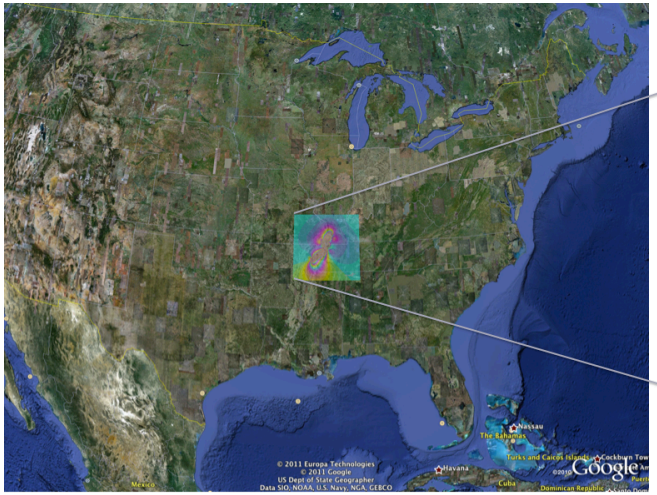
March 13, 2011 1300 UTC



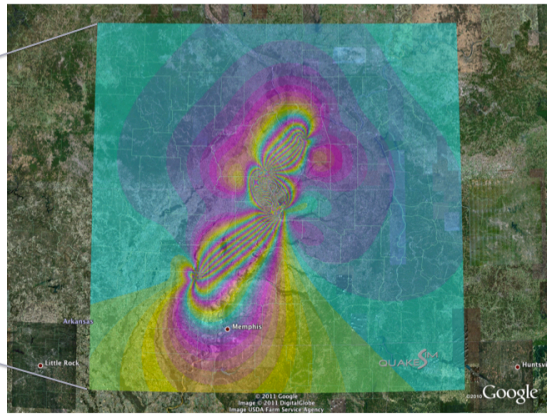
Automated pattern analysis focuses attention on interesting geophysics

Green – no state change
Red – state changes in last hour
Yellow– state changes in last day
Blue – no data

1811-1812 New Madrid Earthquake Sequence & Central US National Level Exercise



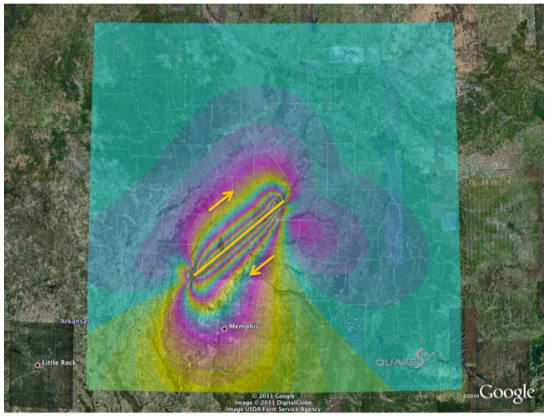
Composite New Madrid Sequence



216 km long rupture
3 meters average horizontal slip
Moment magnitude 7.6

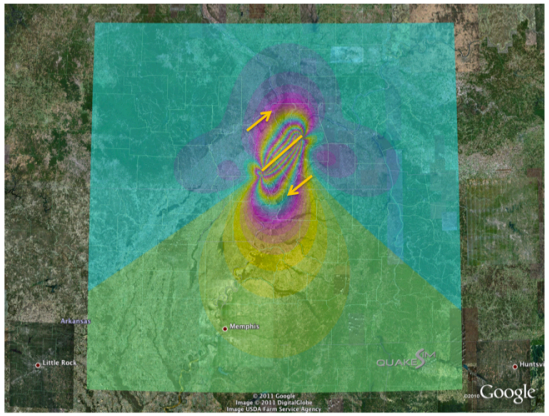
- Illustrates the size and nature of the event
- National Level Exercise
  - May 16th simulated event
  - Generated slope changes
  - Input to E-DECIDER for estimating potential losses

16 December 1811: New Madrid South



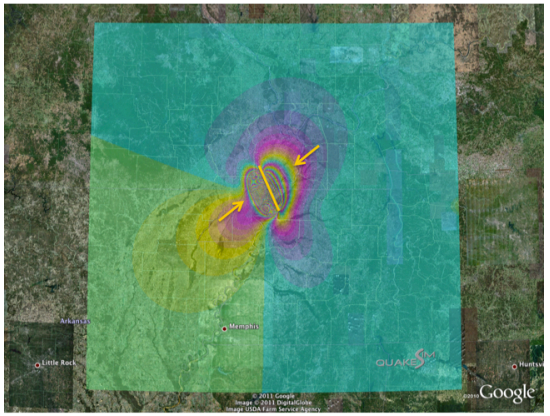
120 km long rupture
3 meters of right-lateral slip
Moment magnitude 7.4

23 January 1812: New Madrid North



56 km long rupture
3 meters of right-lateral slip
Moment magnitude 7.2

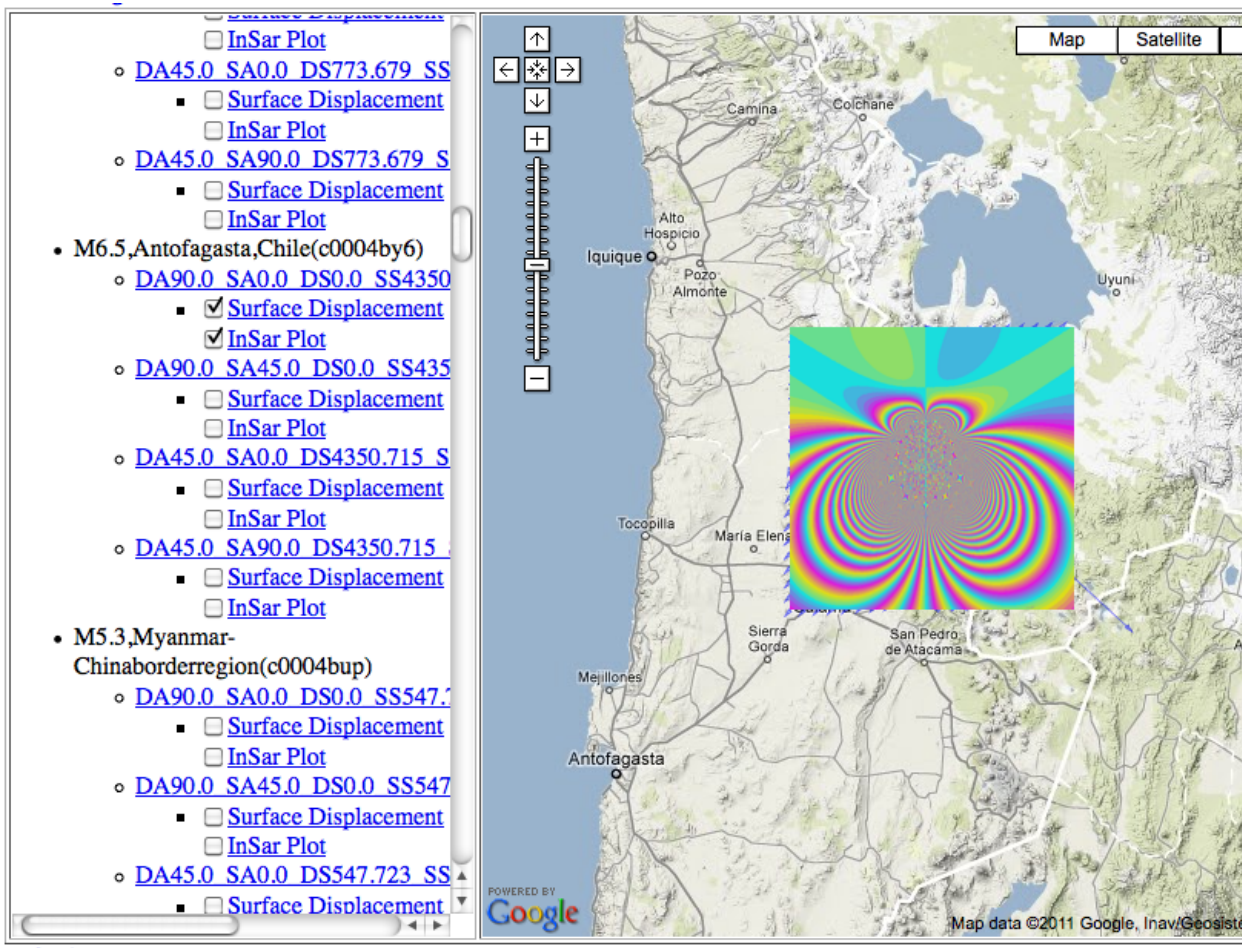
7 February 1812: Reelfoot Fault



40 km long rupture
4 meters of reverse slip
Moment magnitude 7.3

Real-Time Deformation Estimation

Calculate probable displacements for all earthquakes > M 5.0



- Identifying areas of potential surface motions
- Damage estimates
- Rapid deployment of instruments for response
  - UAVSAR
  - GPS

Summary - Interface

- Recent QuakeSim improvements have been driven largely by science analysis cases
  - Analysis provides an efficient means for indicating where further improvements can be made
    - Model applications
    - Interfaces
- Making more of the QuakeSim tools publically available through anonymous interfaces
  - Users are sometimes reticent to create and use logins for conducting analysis
  - Drawback
    - Users can't save, modify, or reuse projects
    - Allows for rapid model development and analysis
  - Want to go to users locally saving and uploading projects

Summary – Science/Users

- The recent earthquakes provide real scenarios for use of QuakeSim tools
- Have spurred many improvements in the interfaces
- Important to engage with end users
  - Ensure utility of the tools
  - Optimize capability